June 19, 1951 J. WISHART ET AL 2,557,584

MACHINE FOR SEMICONTINOUS COATING OF MATERIAL IN STRIP FORM

Filed Jan. 21, 1948 4 Sheets-Sheet 1

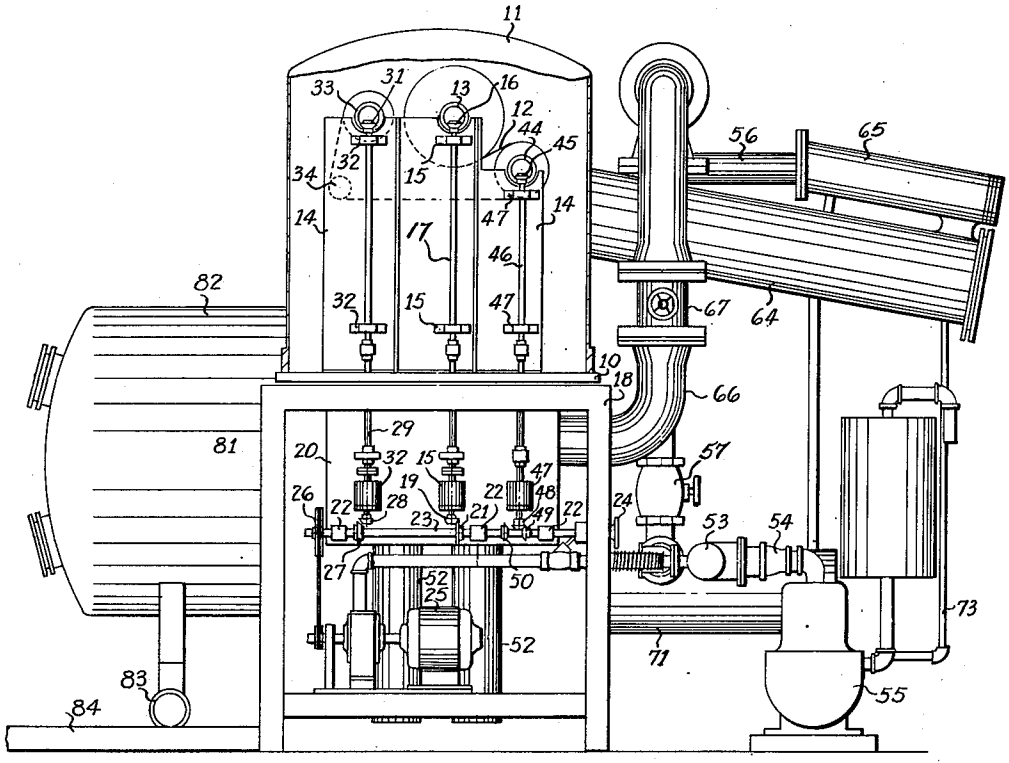

Fig 1

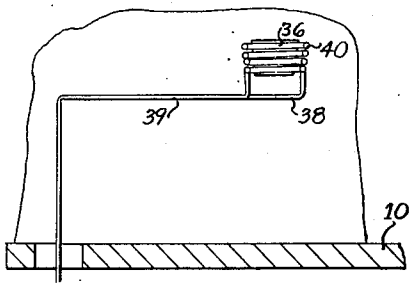

Fig 3

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Allard A. Braddock

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MACHINE FOR SEMICONTINOUS COATING OF MATERIAL IN STRIP FORM

Filed Jan. 21, 1948 4 Sheets-Sheet 2

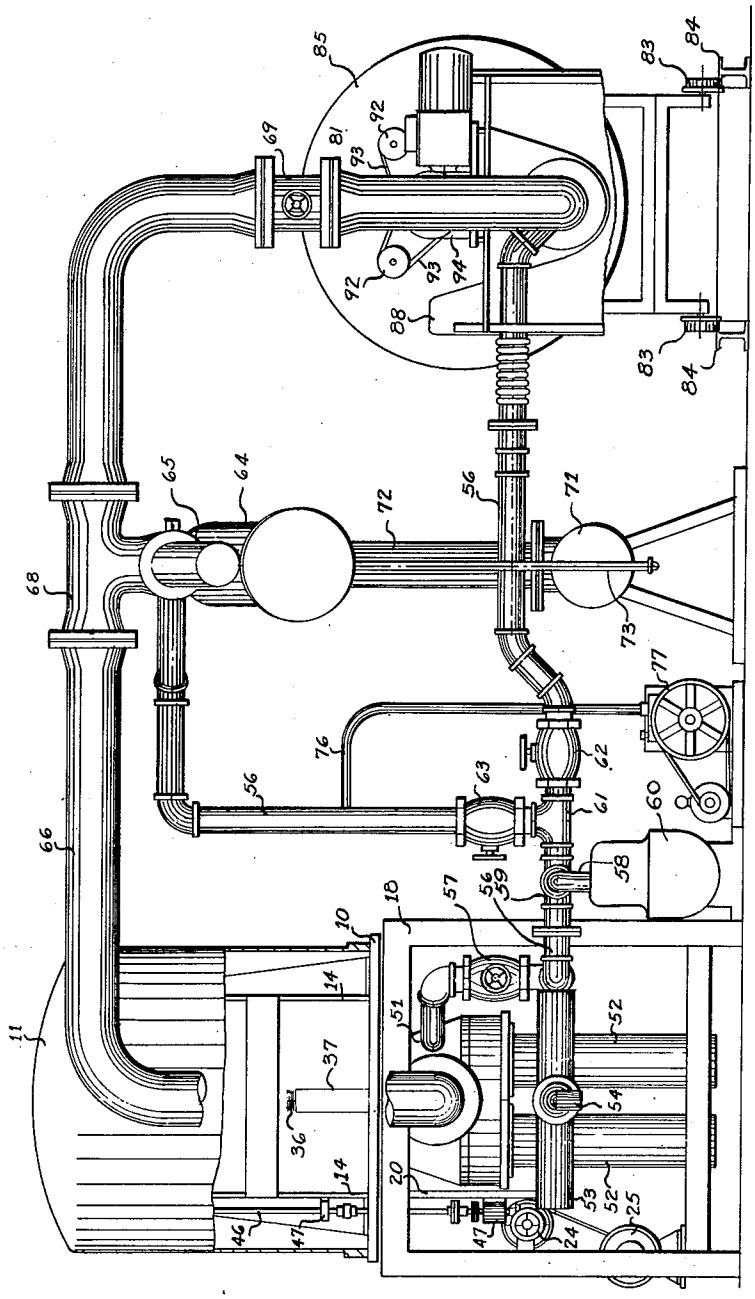

Fig 2

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MACHINE FOR SEMICONTINOUS COATING OF MATERIAL IN STRIP FORM

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4 Sheets-Sheet 3

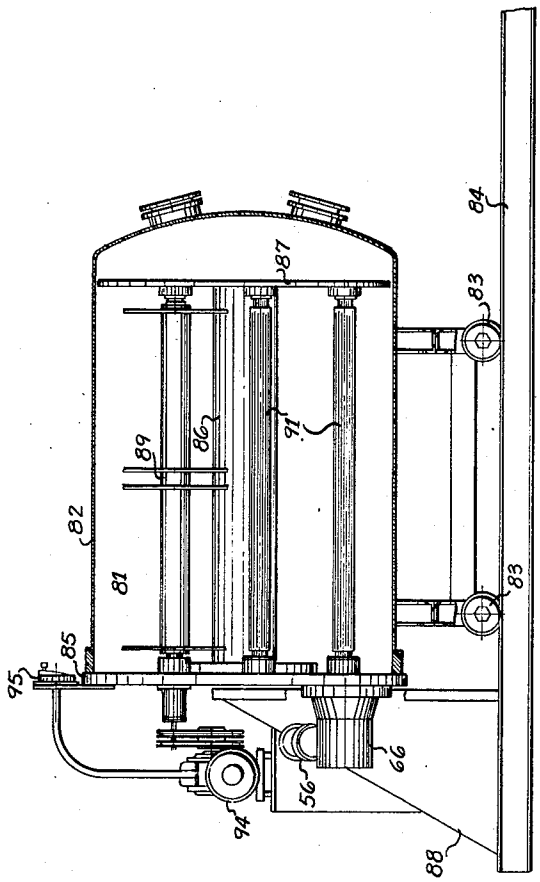

Fig 4

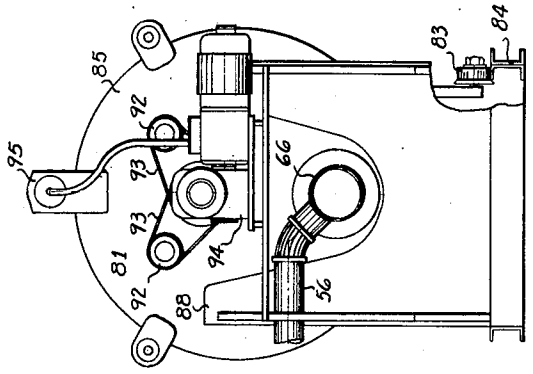

Fig 5

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MACHINE FOR SEMICONTINOUS COATING OF MATERIAL IN STRIP FORM

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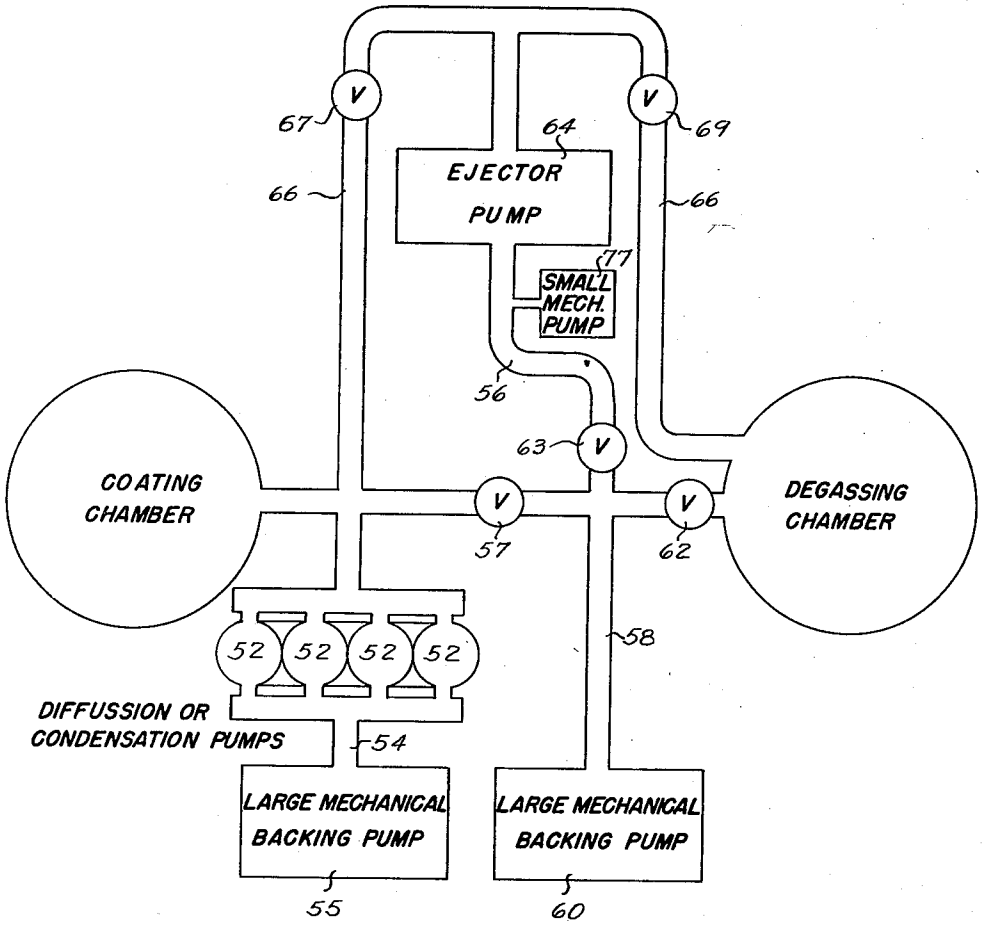

Fig 6

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Patented June 19, 1951 2,557,584

UNITED STATES PATENT OFFICE

2,557,584

MACHINE FOR SEMICONTINUOUS COATING OF MATERIAL IN STRIP FORM

James Wishart and George Hubert Bancroft, Rochester, N. Y., assignors, by mesne assignments, to Eastman Kodak Company, Rochester, N. Y., a corporation of New Jersey

Application January 21, 1948, Serial No. 3,474

4 Claims. (Cl. 91—12.2)

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This invention relates to an improved apparatus for coating materials under vacuum.

It is an object of this invention to provide an apparatus which will effectively and economically coat a roll of strip material under vacuum. Another object is to provide a combination vacuum coating and degassing apparatus with an interconnecting evacuating system arranged for maximum use and efficiency. A further object of this invention is to provide a semi-continuous vacuum coating apparatus of large productive capacity. A still further object is to provide a combination degassing and coating apparatus. Another object is to improve the state of the art. Other objects will appear hereinafter.

These and other objects are accomplished by this invention which, as exemplified by a preferred embodiment, includes a gas-tight coating chamber, means for vaporizing coating material within said chamber, controllable means for rolling and unrolling strip material to be coated within said chamber in proximity to said vaporizing means, means for evacuating said coating chamber to a pressure below about 10 microns Hg, a separate gas-tight degassing chamber for degassing material to be coated, controllable means for rolling and unrolling material to be degassed within said chamber, an ejector pump suitable for operation in about the range 1 mm. Hg —10 microns Hg connected to said coating chamber and said degassing chamber, shut-off valve means between said ejector pump and each chamber, a small mechanical backing pump connected to said ejector pump, valve means for isolating said ejector pump and said small mechanical backing pump from the rest of the apparatus, a mechanical backing pump of substantial capacity with gas-tight connections to said ejector pump, said degassing chamber and said coating chamber, and shut-off valve means in each of said connections for limiting the operation of said mechanical backing pump of substantial capacity to a particular portion of the apparatus. The ejector type oil condensation pump has proved to be very satisfactory but other types of oil condensation pump may be used.

In the accompanying drawings, wherein like numerals refer to like parts, Fig. 1 is a view of the apparatus looking at the coating chamber with the coating chamber walls partially cut away to show the rolls of sheeting material.

Fig. 2 is a view of the apparatus showing both the coating chamber and degassing chamber and with the coating chamber walls partially cut away to reveal the vaporizing element.

Fig. 3 is an enlarged view of the vaporizing unit.

Fig. 4 is a view of the degassing chamber showing the manner in which rolls of material are exposed to the high degassing vacuum.

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Fig. 5 is another view of the degassing chamber.

Fig. 6 is a schematic drawing showing the arrangement whereby evacuating pumps are connected to the coating and degassing chambers and shut-off valves placed in the lines to obtain maximum use and efficiency of the entire unit.

Referring to Figs. 1 to 6, numeral 10 designates the baseplate of the coating chamber which rests on supporting table 18. Bell jar 11 makes gas-tight contact with baseplate 10 while the apparatus is in operation but may be removed while the roll of sheeting material 12 is being changed. The roll of sheeting material 12 is supported by roller 13 which is in turn supported by member 14. Roller 13 is rotated by gear 16 on rotatable shaft 17 which extends upward through baseplate 10 through a gas-tight bearing. Rotatable shaft 17 is held rigid by hangers 15. Gear 19 at the bottom of shaft 17 meshes with gear 21 on rotatable shaft 23. Shaft 23 runs through shaft hangers 22 attached to supporting member 20. This shaft may be moved laterally by operation of control wheel 24. Shaft 23 is rotated by means of force applied to pulley 26 through motor 25. Gear 27 on shaft 23 may be meshed with gear 28 on rotatable shaft 29 by the manipulation of wheel 24. Rotatable shaft 29 passes through a gas-tight bearing in baseplate 10 and is supported by hangers 32. Gear 31 at the top of shaft 29 turns roller 33, which is supported by member 14. Sheeting material 12 is run around roller 44 and idler roller 34. Roller 44 may be turned by gear 45 on rotatable shaft 46. Shaft 46, which is supported by hangers 47, passes through a gas-tight bearing in baseplate 10. Gear 48 on shaft 46 meshes with either gear 49 or gear 50 on rotatable shaft 23.

Evaporating boat 36 on support member 37 is adapted to be filled with the material which it is desired to vaporize. Leads 38 and 39 from induction heating coil 40 are for connection to a source of high frequency electric current whereby the material to be vaporized may be heated to the vaporization temperature.

Extending downward from baseplate 10 is gas-tight manifold 51 which communicates with the coating chamber through an opening in baseplate 10. Communicating with manifold 51 are four diffusion pumps 52 which in turn communicate with exhaust manifold 53. Exhaust manifold 53 is evacuated through conduit 54 by means of mechanical pump 55. Mechanical pump 55 is shown in Fig. 1 but not in Fig. 2.

Conduit 56 is connected through valve 57 to manifold 51. Conduit 58 is attached to conduit 56 through T-connection 59. Attached to con-

duit 58 is mechanical pump 60 similar to mechanical pump 55. In Fig. 1 mechanical pump 60 is directly in back of mechanical pump 55.

Conduit 56 forks at T-connection 61. One fork passes through valve 62 to degassing chamber 31. The other fork passes through valve 63 to condenser 65 of ejector-condensation pump 64.

Conduit 66 runs from manifold 51 through valve 67 to the high-vacuum connection of pump 64. It also runs through T-connection 68 and valve 69 to degasser 31.

Pump 64 is of the oil diffusion type in which boiler 71 heats oil until it vaporizes. These vapors pass up conduit 72 and enter pump chamber 64 where they pass through a nozzle and diffuser. In the course of their passage from conduit 72 through pump chamber 64 the oil vapor molecules have entrained gases from conduit 66. At the lower end of pump chamber 64 most of the oil molecules are condensed and return to the boiler by gravity flow through conduit 73. The noncondensable gases together with a small quantity of oil vapor molecules pass upward into condenser 65 where the remaining oil vapor molecules are condensed and flow back by gravity through conduit 73 to the boiler. The noncondensable gases pass through conduit 56 and are removed by the mechanical pump (not shown) connected to conduit 58.

Conduit 76 is welded to conduit 56. Conduit 76 is connected to small mechanical pump 77. Small mechanical pump 77 is used as a holding pump for oil diffusion pump 64 during periods when it is valved out of the system.

Degassing chamber 31 has a cover plate 32 mounted on wheels 33 for convenience in handling. Wheels 33 move on track 34. Cover plate 32 is in gas-tight connection with baseplate 35 during operation. Baseplate 35 is held by supporting member 38.

Extending perpendicularly from baseplate 35 is column 36 which rigidly supports end plate 37. Extending between baseplate 35 and end plate 37 are rollers 39 and 91. Rollers 91 are idlers while rollers 39 are rotated by pulleys 92 which are driven by belts 93 running between pulleys 92 and motor 94. Control panel 95 is used to reverse and vary the speed of motor 94. The two shafts rotated by pulleys 92 pass through gas-tight bearings in baseplate 35.

The apparatus illustrated in Figs. 1 and 2 may be operated with both the coating and degassing chamber working or with either chamber alone. At the same time either chamber may be brought into operation after the other is operating with minimum shut-down time of the operating chamber. By way of illustration, let it be assumed that it is desired to begin operations. Valves 63, 67, and 69 are closed and mechanical pump 77 is holding oil condensation pump 64 in readiness for operation. Valve 62 is closed and valve 57 opened. Mechanical pump 60 is started and the coating chamber evacuated to the proper pressure (less than 1 mm. Hg) for operation of diffusion pumps 52. Mechanical pump 55 and diffusion pumps 52 are then started and the coating chamber is brought down to operating pressure (about 10–4 mm. Hg or lower). Induction heating coil 40 is energized. Motor 25 is started and the roll of degassed sheet material begins to turn, exposing the material to the molecules vaporizing from boat 36. The coating chamber is now operating.

Valve 57 is closed and valve 62 opened. Pump 60 now operates to bring the pressure of the degassing chamber down to the operating pressure of the oil condensation ejector pump. At this point valve 62 is closed and valves 63 and 69 opened so that oil condensation ejector pump 64 is brought into the system. The pressure is then brought down to about 10 microns Hg and the degassing chamber is ready for degassing operations. Motor 94 is started and rolls of work material (not shown) are unwound from one of the rollers 39 around the idler rollers 91 and rewound on the other roller 39. Exposure to the high degree of vacuum removes gases from the material and places it in proper condition for use in the coater. Motor 94 may be reversed so as to provide for repeated exposure of the roll of material to the degassing action of the vacuum.

If it is desired to place the coating unit in operation after the degassing unit has been started, it is a simple matter to close valves 62, 63, and 69 and open valve 57. Oil condensation ejector pump 64 is then held in operating condition by mechanical pump 77 (which operates whether pump 60 is or is not backing up pump 64) and pump 60 takes the coating chamber down to the pressure where diffusion pumps 52 are effective whereupon pumps 52 backed by pump 55 are put into operation. This takes no more than about 5 minutes and the degassing chamber may then be quickly placed in operation again.

Valve 67 is used when it is desired to employ the coating chamber as a degasser. In this event valves 62, 63, 67, and 69 are closed and valve 51 is opened. Pump 60 then brings the coating chamber, now serving as a degassing chamber, down to about 1 mm. Hg pressure. Valves 63 and 67 are then opened and valve 57 is closed. Oil condensation ejector pump 64 then takes the coating chamber down to about 10 microns pressure and it is ready to serve as a degasser.

The material to be coated may take a wide variety of forms since this material acts merely as a condensing surface for vapors of the substance doing the coating. Natural fibers such as cotton and silk may be used but the coating is usually not very adherent. Artificial materials such as cellulose acetate, cellulose nitrate, and glass fabrics form good bases for the coating of adherent films. Substances which may be vaporized and coated on the above-mentioned materials include nonconductors as well as conductors. Usually it is desired to coat with metals such as aluminum, nickel, beryllium, platinum, gold, silver, etc., but a nonconductor such as quartz may also be used.

While the invention has been described in considerable detail with reference to a preferred embodiment thereof, it will be understood that modifications and variations therein may be effected without departing from the spirit and scope of the invention as it is defined by the appended claims.

What we claim is:

1. Apparatus for degassing and coating material under vacuum comprising in combination a gas-tight chamber for containing material to be treated, a mechanical backing pump of substantial capacity, conduit means connecting said mechanical backing pump and said chamber, valve means in said conduit means between said mechanical backing pump and said chamber for closing said conduit means, an ejector pump having a pumping range of about 10–1000 microns

Hg, secondary conduit means connecting the low pressure side of said ejector pump with said chamber and connecting the high pressure side of said ejector pump with said first-named conduit means between said valve means and said mechanical backing pump, shut-off valve means in said secondary conduit means on each side of said ejector pump for isolating said ejector pump from the remainder of said apparatus, and high vacuum pumping means connected to said chamber for evacuating said chamber in the pressure range below about 10 microns Hg and comprising a plurality of diffusion pumps backed by a second mechanical pump of substantial capacity.

2. Apparatus for degassing and coating material under vacuum comprising in combination a gas-tight coating chamber and a separate gas-tight degassing chamber, conduit means extending between said chambers in communication with each said chamber, a mechanical backing pump of substantial capacity communicating with said conduit means, spaced-apart valve means in said conduit means for closing said conduit means between said mechanical backing pump and each said chamber, an ejector pump having a pumping range of about 10–1000 microns Hg, secondary conduit means connecting the low pressure side of said ejector pump with said degassing chamber and connecting the high pressure side of said ejector pump with said first-named conduit means at a point between said spaced-apart valve means, shut-off valve means in said secondary conduit means on each side of said ejector pump for isolating said ejector pump from the remainder of the system, and pumping means connected to said coating chamber for evacuating said coating chamber in the pressure range below about 10 microns Hg.

3. Apparatus for degassing and coating material in strip form under vacuum comprising in combination a gas-tight coating chamber, means for vaporizing coating material within said chamber, controllable means for rolling and unrolling material to be coated within said chamber in proximity to said vaporizing means, a separate gas-tight degassing chamber for degassing material to be coated, controllable means for rolling and unrolling material to be degassed within said chamber, conduit means connecting said chambers, spaced-apart valve means in said conduit means, a mechanical backing pump of substantial capacity connected with said conduit means between said spaced-apart valve means, an ejector pump having a pumping range of about 10–1000 microns Hg, high pressure conduit means connecting the high pressure side of said ejector pump to said first-named conduit means between said spaced-apart valve means, branched low

pressure conduit means connecting the low pressure side of said ejector pump with said coating chamber and said degassing chamber respectively, shut-off valve means in said low pressure and high pressure conduit means respectively for isolating said ejector pump, and high vacuum pumping means connected to said coating chamber for evacuating said coating chamber in the pressure range below about 10 microns.

4. Apparatus for degassing and coating material in strip form under vacuum comprising in combination a gas-tight coating chamber, means for vaporizing coating material within said chamber, controllable means for rolling and unrolling material to be coated within said chamber in proximity to said vaporizing means, a separate gas-tight degassing chamber, controllable means for rolling and unrolling material to be degassed within said chamber, conduit means connecting said chambers, spaced-apart valve means in said conduit means, a mechanical backing pump of substantial capacity connected to said conduit means between said spaced-apart valve means, an ejector pump having a pumping range of about 10–1000 microns Hg, a small mechanical pump connected and arranged to back said ejector pump, secondary conduit means connecting said ejector pump with the remainder of said apparatus, said secondary conduit means comprising a conduit connecting the high pressure side of said ejector pump with said first-named conduit means between said spaced-apart valve means and a second conduit extending from the low pressure side of said ejector pump and being branched with a conduit branch connecting said ejector pump with each of said chambers, shut-off valve means in said secondary conduit means for isolating said ejector pump and small mechanical pump from the remainder of the apparatus, and pumping means connected with said coating chamber for evacuating said chamber in the pressure range below about 10 microns Hg and comprising a plurality of diffusion pumps backed by a second mechanical backing pump of substantial capactiy.

JAMES WISHART.
GEORGE HUBERT BANCROFT.

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The following references are of record in the file of this patent:

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2,402,269	Alexander et al.	June 18, 1946

Certificate of Correction

Patent No. 2,557,584 June 19, 1951

JAMES WISHART ET AL.

It is hereby certified that the name of co-inventor in the above numbered patent was erroneously described and specified as "George Hubert Bancroft" whereas said name should have been described and specified as *George Herbert Bancroft*; in the printed specification, column 4, line 35, for "valve 51" read *valve 57*; and that the said Letters Patent should be read as corrected above, so that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 25th day of September, A. D. 1951.

[SEAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.